PATENT SPECIFICATION (11) 1 410 014

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(21) Application No. 56127/71 (22) Filed 14 Dec. 1971
(23) Complete Specification filed 8 Dec. 1972
(44) Complete Specification published 15 Oct. 1975
(51) INT. CL.² F01D 5/18
(52) Index at acceptance
F1T 2F2B

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(19)

(54) GAS TURBINE ENGINE BLADE

(71) We, ROLLS-ROYCE (1971) LIMITED of 14-15 Conduit Street, London, W1A 4EY, a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to gas turbine engine blades.

According to this invention there is provided a gas turbine engine blade of hollow aerofoil section comprising two opposite walls defining the high and low pressure sides of the blade, substantially chordwise ribs provided at the interior surfaces of the walls between the leading and trailing edges thereof, the ribs of the one wall confronting spaces formed between adjacent ribs of the other wall so that cooling air passing through the blade generally in the spanwise direction is directed by the ribs alternately to the two walls.

Various exemplary embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows a mid-section (on line B-B in Figure 2) of a typical gas-turbine rotor blade;

Figure 2 shows a section on line A-A in Figure 1 of that blade;

Figures 3*a* and 3*b* show sections respectively on B-B and C-C in Figures 2 and 1 of a first form of turbine blade according to the invention;

Figures 4*a* and 4*b* show views similar to Figures 3*a* and 3*b* of a second form;

Figures 5*a* and 5*b* shows views similar to Figures 3*a* and 3*b* of a third form, and

Figure 6 shows a view similar to Figure 3*b* of a fourth form of turbine blade.

As seen in Figures 1 and 2, a turbine rotor blade has an aerofoil cross-section 10, with a leading edge 11 and a trailing edge 12. It is generally hollow and accepts a cooling air flow in the direction of arrow 13 from the root end 14 towards the shroud end 15. The blade shown is cast in one piece and its interior space is formed by the use of a ceramic core which is dissolved out after the casting operation. This core allows the formation of internal walls and/or projections, useful both for strengthening purposes and for guiding the airflow. These walls and/or projections extend from the internal surfaces 16, 17 of the two curved surfaces of the blade.

A first form of blade according to the invention is shown diagrammatically in Figures 3*a* and 3*b*. Ribs 18 extend from the leading edge 11 to the trailing edge 12, and are integral alternately with the surfaces 16 and 17. However, none of the ribs extends fully across the width between the internal surfaces of the blade, so that the ribs on surface 16 stop short of surface 17, and vice-versa (Figure 3*b*). Thus, the air flow through the blade is forced to follow a sinuous path, impinging alternately on the surfaces 16,17 in the spaces between adjacent ribs 18. These changes of direction aid cooling by ensuring that the air effectively absorbs heat from the surfaces it is to cool. Equally, the ribs themselves carry heat from the surface to be cooled and provide extra heat transfer surfaces.

In a second form of blade shown in Figure 4*a* and 4*b*, similar ribs 18 are provided, but in this case slope relative to the longitudinal direction of the blade. The slope is such that the air flow tends to be deflected towards the leading edge 11 of the blade. This is an advantage, since it is the leading edge particularly which needs cooling, and this construction ensures a concentration of air flow at that edge.

Particularly good overall cooling is obtained, by the arrangement of Figures 5*a* and 5*b*. In this the ribs 20, 21 on opposite

internal surfaces 16, 17 of the blade slope in opposite directions. Consequently, the air flow path is particularly tortuous, and there is good opportunity to heat transfer between the hot surfaces and the air.

Figure 6 shows a modification of the plain form of Figures 3*a* and 3*b*. In this case the ribs are formed by wave formation which eliminates the angles between the ribs 18 and the surfaces from which they project. These angles tend to form pockets of dead air which not only do not carry away the heat they have absorbed, but prevent fresh cooling air reaching the surfaces they cover. The form shown in Figure 6 does not suffer that disadvantage.

Apart from the efficacy of cooling provided by turbine blades as described, the arrangement, at least in Figures 3 and 4 has a further advantage in manufacture. As mentioned, the hollow space in the blade is produced by casting around a hollow ceramic core. The core is formed using separable mould halves.

In the past, it has been common to provide in the blade, projections extending right across between surfaces 16 and 17. This requires a core with holes completely through it, which in turn requires mould halves having projections which meet exactly in a mid-plane. Such exact abutment has often proved a difficulty, and it is an advantage that for the illustrated embodiments mentioned it is not needed.

The form of blade described above is not, however, limited to manufacture by casting.

WHAT WE CLAIM IS:—

1. A gas turbine engine blade of hollow aerofoil section comprising two opposite walls defining the high and low pressure sides of the blade, substantially chordwise ribs provided at the interior surfaces of the walls between the leading and trailing edges thereof, the ribs of the one wall confronting spaces formed between adjacent ribs of the other wall so that cooling air passing through the blade generally in the spanwise direction is directed by the ribs alternately to the two walls.

2. A gas turbine engine blade substantially as described herein with reference to Figs. 1-3 or Figs. 4, 5 or 6 of the accompanying drawing.

For the Applicants,
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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1975.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG. 1

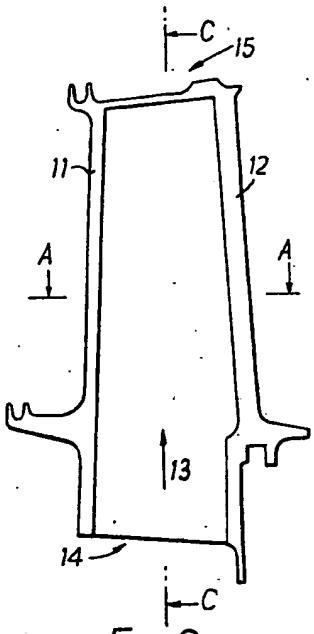

FIG. 2

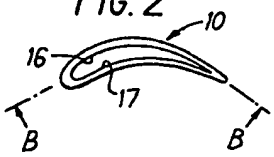

FIG. 3

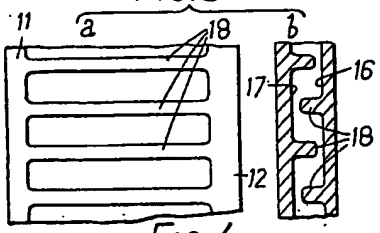

FIG. 4

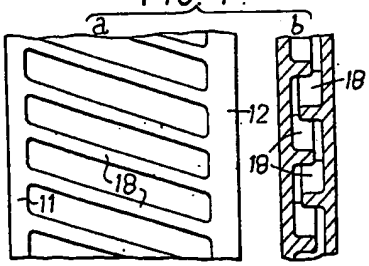

FIG. 5

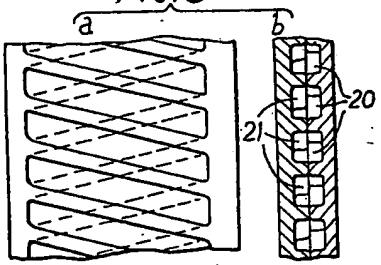

FIG. 6